

Appl. No. 10/006,578
Reply to Office action of 02/19/2004

Applicant respectfully submits that claim 1 is patentable over Sandhu et al in view of Sekiguchi et al, as there is no disclosure or suggestion in the references of forming a conductive liner in a hole, annealing the conductive liner, after annealing the conductive liner, treating the conductive liner with hydrogen and forming a conductive barrier over the conductive liner. Sandhu teaches forming a titanium liner in a contact hole, converting a bottom portion of the liner to silicide by annealing, and forming a titanium nitride barrier over the liner. As noted by the Examiner, Sandhu does not teach treating the conductive liner with hydrogen. Sekiguchi teaches treating a silicide layer with nitrogen or hydrogen at the bottom of a contact to form a barrier compound layer. Sekiguchi teaches that, with the formation of the barrier compound layer, the reaction between the silicide and a buried layer can be avoided without depositing a barrier metal such as TiN. While Sandhu lacks the teaching of hydrogen treatment of the liner and Sekiguchi teaches hydrogen treatment of a silicide layer, the combined teachings of the references fail to suggest the claimed invention. At most Sekiguchi would suggest modifying Sandhu to treat the silicide portion of the liner with nitrogen or hydrogen and eliminate the depositing of the barrier since Sekiguchi teaches the purpose for the nitrogen/hydrogen treatment is to eliminate the barrier metal deposition. However, claim 1 requires both the hydrogen treatment and the deposition of the barrier layer. This is not suggested by the references.

Furthermore, Sekiguchi teaches the nitrogen/hydrogen treatment of a silicide layer. The silicide layer in Sekiguchi is not a liner and the liner in Sandhu is titanium not silicide (although a portion of the liner is eventually converted to silicide). The references do not disclose or suggest forming a conductive liner in a hole, annealing the conductive liner, after annealing the conductive liner, treating the conductive liner with hydrogen and forming a conductive barrier over the conductive liner. Accordingly, Applicant respectfully submits that claim 1 and the claims dependent thereon are patentable over the references.

Applicant respectfully submits that claim 9 is patentable over Sandhu in view of Sekiguchi as there is no disclosure or suggestion in the references of depositing

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titanium over a dielectric layer including within a contact hole, annealing the titanium, treating the titanium with hydrogen prior to the annealing step, and depositing TiN over the titanium. As discussed above Sandhu failed to teach treating the titanium with hydrogen. Sekiguchi teaches treating a silicide with nitrogen/hydrogen. Sekiguchi does not disclose or suggest treating titanium with hydrogen. Neither of the references disclose or suggest treating titanium with hydrogen as required by claim 9.

Even if there were a suggestion to modify the process of Sandhu to include the hydrogen treatment of a silicide layer such as that in Sekiguchi, there still is no suggestion of treating the titanium with hydrogen prior to the annealing step. The annealing step in Sandhu creates the silicide portion of the liner. Therefore, since Sekiguchi teaches the treatment of a silicide layer, this treatment could only be performed after the silicide is created which, in Sandhu, is after the annealing step. Therefore, there is no disclosure or suggestion of treating the titanium with hydrogen prior to the annealing step.

Furthermore, Sekiguchi teaches performing the nitrogen/hydrogen treatment for the purpose of creating a compound barrier layer and eliminating the depositing of a barrier metal. There is no disclosure or suggestion for both treating with hydrogen and depositing TiN over the titanium, as required by claim 9.

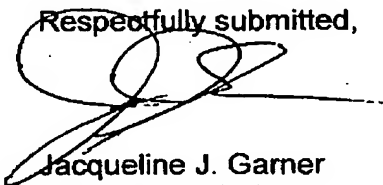
For the above reasons, Applicant respectfully submits that claim 9 and the claims dependent thereon are patentable over Sandhu in view of Sekiguchi.

Applicant respectfully submits that dependent claims 8 and 16 are further patentable over the references as there is no disclosure or suggestion in the references of repeating the treating step prior to the filling step. Sandhu does not disclose a treating step. Sekiguchi discloses only one treating step. Sekiguchi teaches treating a silicide layer. There is only one silicide portion/layer taught in each reference. There is no disclosure or suggestion in the references for repeating a treating step prior to the filling step.

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In light of the above, Applicant respectfully requests withdrawal of the Examiner's rejections and allowance of claims 1, 4-9, and 11-16. If the Examiner has any questions or other correspondence regarding this application, Applicant requests that the Examiner contact Applicant's attorney at the below listed telephone number and address.

Respectfully submitted,



Jacqueline J. Garner
Reg. No. 36,144

Texas Instruments Incorporated
P. O. Box 655474, M.S. 3999
Dallas, Texas 75265
Phone: (214) 532-9348
Fax: (972) 917-4418